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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/830,035	04/23/2004	Rabah Boukherroub	16627-US	7505

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EXAMINER

DAHIMENE, MAHMOUD

ART UNIT	PAPER NUMBER
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1765

DATE MAILED: 07/26/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

## Office Action Summary

Application No.

10/830,035

Applicant(s)

BOUKHERROUB ET AL.

Examiner

Mahmoud Dahimene

Art Unit

1765

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --  
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

### Status

- 1) ☒ Responsive to communication(s) filed on 26 April 2006.  
2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.  
3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

### Disposition of Claims

- 4) ☒ Claim(s) 1-25 is/are pending in the application.  
4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.  
5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.  
6) ☒ Claim(s) 1-25 is/are rejected.  
7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.  
8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

### Application Papers

- 9) ☐ The specification is objected to by the Examiner.  
10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).  
11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

### Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).  
a) ☐ All b) ☐ Some \* c) ☐ None of:  
1. ☐ Certified copies of the priority documents have been received.  
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.  
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).  
\* See the attached detailed Office action for a list of the certified copies not received.

### Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)  
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)  
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)  
Paper No(s)/Mail Date \_\_\_\_\_.  
4) ☐ Interview Summary (PTO-413)  
Paper No(s)/Mail Date \_\_\_\_\_.  
5) ☐ Notice of Informal Patent Application (PTO-152)  
6) ☐ Other: \_\_\_\_\_.

## DETAILED ACTION

### ***Claim Rejections - 35 USC § 103***

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

2. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

3. Claims 1-11 and 13-18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sieval et al. (Langmuir (American Chemical Society) (1998) 14, 1759-1768) in view of Yamada et al. (US 2002/0158256) and further in view of Effenberger et al. (Angew. Chem. Int. Ed., 1998, 37, No. 18, pp. 2462-2464).

Sieval et al. describe a highly stable Si-C linked functionalized monolayers on a silicon surface obtained using a method comprising the steps of preparing a silicon substrate (structure) having a surface terminated with hydrogen atoms (figure 1). The reference of Sieval teaches formation of a stable monolayer formed from Si-C bonds on a Si-H terminated surface, the formation of a monolayer suggests that all Si-H bonds reacted to form the Si-C bonds which in turn suggests the monolayer is effective in sealing (passivating) the silicon surface. There is no indication in the publication suggesting that the method described by Sieval et al. does not form a passivation layer if applied to a porous silicon surface. Sieval et al. use an organic thermal processing with alkene reactants which have been distilled and deoxygenated and reacted with Si-H at 200°C (page 1761, in paragraph: Monolayer Preparation) which meets the limitation of instant claim 1 “the reactants are purified to free them of peroxide and hydroperoxide impurities prior to said thermal processing”. No external catalysts are disclosed. Sieval discloses “This makes this new reaction, in combination with the stability of the resulting monolayers, potentially very interesting for many application, e.g. in nonlinear optics and absorption experiments” (introduction, page 1759).

A difference is noted between the reference of Sieval and applicants claim 1, Sieval et al. fail to disclose the form of silicon as a porous silicon and the function of the added layer is to protect the porous silicon from luminescent fatigue.

The reference of Yamada teaches porous silicon luminescent instability over time is caused by silicon surface oxidation (page 1, paragraph 0007), and a silicon nitride passivation layer allows improved stability by preventing oxidation of the silicon surface.

Therefor, it would have been obvious to one of ordinary skill in the art at the time the invention was made to stabilize porous silicon in the reference of Sieval because the reference of Yamada illustrates that surface passivation is desirable for luminescent stability of porous silicon, and Sieval's method forms a stable (passivating) monolayer desirable for protecting from oxidation which leads to luminescent fatigue.

Another difference is noted between the reference of Sieval and applicants claim 1, Sieval et al. fail to disclose reactants selected from the group consisting of  $RCH=X$ ,  $R^1R^2C=X$  where  $X=O$ ,  $NR'$ ,  $S$ ) and  $RNu$  where  $Nu=OH$ ,  $NHR'$ ,  $SH$ ,  $COOH$ . (Examiner notes that  $RCH=O$  is an aldehyde).

Effenberger et al. disclose a photoactivated preparation and patterning of self assembled monolayers with alkenes and/or aldehydes on silicon hydride surfaces. The self assembled layer is prepared by reaction of hydrogen-terminated Si surface either with alkenes (page 2462, paragraph 3) or with aldehydes (page 2462, paragraph 5) (Scheme 1). It is noted that, in Effenberger's reference, the reaction was activated by radiation energy as opposed to thermal energy. As to the length of the carbon chains in the reactant, a  $(CH_2)_{14}$  chain is shown in scheme 1 (page 2462).

Therefor, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the method of Sieval et al. by replacing the alkene (1) reactant with an aldehyde (2) reactant because Effenberger et al. show both reactants can be used for the formation of stable monolayers on a silicon surfaces. Sieval et al. show that thermal energy can be used for reaction activation in the case of alkenes, in the absence of unexpected results, one of ordinary skill in the art would expect that

Art Unit: 1765

thermal energy would also activate the reaction with aldehydes. One of ordinary skill in the art would have been motivated to use an aldehyde as a reactant because the test results of Table 1 (of Effenberger et al, page 2462) show better coverage with reactant 2. One of ordinary skill in the art would have been motivated to use the modified method of Sieval over the nitration method of Yamada because the method of Sieval is a lower temperature process, which is desirable when forming optical devices on a substrate requiring stricter thermal management.

As to claim 4, Effenberger et al. show a Si surface bonded molecule chain with a length  $(\text{CH}_2)_{11}$  (Scheme 1, page 2462) which is shorter than the reactant molecule chain  $(\text{CH}_2)_{14}$ . Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to expect a bonded organic layer with a thickness equal or less than the length of the molecule of the reactant used in the process because Effenberger et al. show an example where the surface bonded carbon chain has been experimentally identified as being shorter in length than the corresponding reactant chain.

As to claim 5, Effenberger et al. measured both C-O and Si-O covalent bonds with  $(\text{CH}_2)_{11}$  chains using (XPS)(Scheme 1, and paragraph 6, page 2462). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to expect a bonded organic layer with Si-O-C bonds because the reference of Effenberger et al. measured C-O and Si-O bonds with an XPS method.

As to claim 6, Effenberger et al. use Octadecanal (page 2462, paragraph 5)(which is an octyl aldehyde). Therefore, it would have been obvious to one of ordinary skill

Art Unit: 1765

in the art at the time the invention was made to modify the method of Sieval et al. by using an octyl aldehyde as a reactant because Effenberger et al. show that this type of reactants can be used to obtain stable carbon bonded layers with high coverage.

As to claims 7-9 and 18, Effenberger et al. discuss examples where reaction temperature are 20-50°C (table 1, page 2462), in these examples radiation was necessary for activation, therefore, one of ordinary skill in the art would have expected the activation temperature to be higher than 50°C when no radiation is used and thermal energy is the only activation energy. Also, Sieval et al. disclose an activation temperature of 200°C (page 1759, paragraph 3 of the introduction). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to expect the activation temperature for the bonding process to have a lower limit of 50°C, and the higher limit to be higher than 200 °C, but not considerably higher such that delicate structures are not affected by the processing heat. Applicants have not shown anything critical with respect to the process temperature. In the absence of unexpected results, it would appear that any process temperature from 50°C to about 250°C could have been used for forming a monolayer.

As to claim 10, Sieval et al. use a distillation process for the reactant (page 1761, paragraph 3).

As to claim 11, Sieval et al. disclose, in the experimental section (syntheses) (page 1760), a mixture comprising methanol, and drying is used in the preparation of the sample.

As to claim 13 and 14, Sieval et al. disclose drying the surface with dry nitrogen gas prior to exposing to reactants (page 1761, paragraph 3).

As to claim 15, Sieval et al. discloses a deoxygenated reactant (page 1761, paragraph 3).

As to claim 16, Sieval et al. take reasonable measures for removing oxygen from the process, but one of ordinary skill in the art would know the deoxygenation method of Sieval et al. does not eliminate all oxygen from the reaction, therefore, some small oxidation is expected during thermal processing if 100% of the oxygen is not removed, the applicant did not specify what level of oxidation is permitted. A more rigorous deoxygenation would involve processing under high vacuum, for example.

As to claim 17, Sieval et al. discuss an undecenyl alcohol which could be ethyl undecelene and ester formation (page 1760, bridging paragraph from page 1759).

4. Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over Sieval et al. (Langmuir (American Chemical Society) (1998) 14, 1759-1768) in view of Yamada et al. (US 2002/0158256) and Effenberger et al. (Angew. Chem. Int. Ed., 1998, 37, No. 18, pp. 2462-2464) as applied to claims 1-11 above, and further in view of Akatsu et al. (5,932,493).

The modified method of Sieval et al. is silent about rinsing the silicon structure with ethanol.

Akatsu et al. cite that substrate rinsing with ethanol and drying is conventionally used in semiconductor manufacturing (column 4, line 32).



Therefor, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the method of Sieval by adding a rinsing step with ethanol because the reference of Akatsu et al. teaches that rinsing with ethanol and drying is effective in removing stains on the substrate. One of ordinary skill in the art would have been motivated to remove stains on the substrate in order to obtain a reliable product with well prepared surface for uniform monolayer coating.

5. Claims 19-25 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sieval et al. (Langmuir (American Chemical Society) (1998) 14, 1759-1768) in view of Yamada et al. (US 2002/0158256) and Effenberger et al. (Angew. Chem. Int. Ed., 1998, 37, No. 18, pp. 2462-2464) as applied to claims 1-11 and 13-18 above, and further in view of Schmuki et al. (US 6,284,671).

The modified method of Sieval et al, discussed above, includes a step of etching silicon in 2% hydrofluoric acid (page 1761, paragraph 3) to remove native oxide and produce a hydrogen-terminated surface (figure 1).

The combined method of the references of Sieval et al., Yamada and Effenberger et al. suggest the production of an organic layer of a silicon structure with an aldehyde reactant purified by distillation and without external catalyst.

It is noted that the modified method of Sieval et al. is silent about electrochemically etching the hydrogen-terminated surface to provide a porous silicon film.

Art Unit: 1765

The reference of Schmuki et al. teaches a selective electrochemical process for creating semiconductor nano and micro-patterns including a porous silicon layer (column 3, line 2).

Therefor, it would have been obvious to one of ordinary skill in the art at the time the invention was made to further modify the method of Sieval et al. with the addition of the step of electrochemically etching the hydrogen-terminated silicon substrate to provide a porous silicon film because the modified method of Sieval et al. provides a very stable carbon-based monolayer bonded to the silicon surface to protect it, and the same method can be used to cover porous silicon. One of ordinary skill in the art would have been motivated to combine the 3 references cited above in order to obtain a stable porous silicon surface which is desirable for the fabrication of reliable semiconductor components requiring an exposed porous silicon surface.

As to claim 22, Effenberger et al. discuss examples where reaction temperature are 20-50°C (table 1, page 2462), in these examples radiation was necessary for activation, therefore, one of ordinary skill in the art would have expected the activation temperature to be higher than 50°C when no radiation is used and thermal energy is the only activation energy. Sieval et al. disclose an activation temperature of 200°C (page 1759, paragraph 3 of the introduction). Therefor, it would have been obvious to one of ordinary skill in the art at the time the invention was made to expect the activation temperature for the bonding process to have a lower limit of 50°C, and the higher limit to be higher than 200°C, but not considerably higher so delicate structures are not affected by the processing heat. Applicants have not shown anything critical with respect to the

Art Unit: 1765

process temperature. In the absence of unexpected results, it would appear that any process temperature from 50°C to about 250°C could have been used for forming a monolayer.

As to claim 23, Effenberger et al. show a Si surface bonded molecule chain with a length  $(\text{CH}_2)_{11}$  (Scheme 1, page 2462) which is shorter by is interpreted as substantially equal to the length of reactant molecule chain  $(\text{CH}_2)_{14}$ . Therefor, it would have been obvious to one of ordinary skill in the art at the time the invention was made to expect a bonded organic layer with a thickness equal or less than the length of the molecule of the reactant used in the process because Effenberger et al. show an example where the surface bonded carbon chain has been experimentally identified as been shorter (or substantially equal) in length relative to the corresponding reactant chain.

As to claim 24, Effenberger et al. measured C-O and Si-O covalent bonds with  $(\text{CH}_2)_{11}$  chains using (XPS) (Scheme 1, and paragraph 6, page 2462). Therefor, it would have been obvious to one of ordinary skill in the art at the time the invention was made to expect a bonded organic layer with Si-O-C bonds because the reference of Effenberger et al. measured C-O and Si-O bonds with an XPS method.

As to claim 25, Effenberger et al. disclose octadecanal (Stearaldehyde) as a reactant. Therefor, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use octadecanal as the reactant in the modified method of Sieval et al. because this reactant is disclosed by Effenberger et al.

***Response to Arguments/Remarks***

6. Applicant's arguments, see pages 5-10, filed On 04/26/2006 with respect to the rejection(s) of claim(s) 1-25 under 35 USC § 103 have been fully considered and are persuasive. Therefore, the rejection has been withdrawn. However, upon further consideration, a new ground(s) of rejection is made in view of Sieval et al. (Langmuir (American Chemical Society) (1998) 14, 1759-1768), Yamada et al. (US 2002/0158256) and Effenberger et al. (Angew. Chem. Int. Ed., 1998, 37, No. 18, pp. 2462-2464).

Regarding applicants argument (page 6) related to the surface roughness of porous silicon does not allow formation of a monolayer, the examiner notes that Sieval concern with the surface roughness is related only to the measurement of water contact angles for the purpose of comparison with other stable layers, since surface flatness affects contact angles measurements as well as other optically related measurements. The passivation property of a silicon surface suggested by Yamada for luminescence stability does not require a perfect monolayer as required by Sieval for measurements related to the layer characterization, the passivating property can be achieved as long as all the Si-H bonds yield Si-C bonds on the porous silicon surface which appears to be achievable with Sieval's modified method. Sieval does not teach away from using his method for surface passivation, he is mainly concerned with the achievement of a stable monolayer, therefore, the proposed modification would not change the principle of operation.

***Conclusion***

7. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Mahmoud Dahimene whose telephone number is (571) 272-2410. The examiner can normally be reached on week days from 8:00 AM. to 5:00 PM..

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nadine Norton can be reached on (571) 272-1465. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Art Unit: 1765

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MD

NADINE WORTON  
SUPERVISORY PATENT EXAMINER  
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